The engineering stress σ_E and strain ε_E of materials are calculated based on data from tensile tests:

$$\sigma_E = \frac{F}{A_0}, \varepsilon_E = \frac{\Delta L}{L_0} \tag{S1}$$

Where A_0 represents the initial cross-sectional area of the specimen, L_0 denotes the initial length of the specimen, and F refers to the force applied during the tensile test. Similarly, the true stress and strain of the material is defined as:

$$\sigma_T = \frac{F}{A}, \varepsilon_T = \frac{\Delta L}{L} \tag{S2}$$

Where A represents the true cross-sectional area, and L denotes the true length of the specimen. Based on the principle of volume constancy of the specimen, it follows that:

$$A_0 L_0 = AL \tag{S3}$$

Subsequently, the equation can be transformed as follows:

$$\frac{A_0}{A} = \frac{L}{L_0} \tag{S4}$$

Thus, the relationship between the engineering stress and true stress can be described as follows:

$$\sigma_T = \frac{F}{A} = \frac{F}{A_0}\frac{A_0}{A} = \frac{F}{A_0}\frac{L}{L_0} = \frac{F}{A_0}\frac{L - L_0 + L_0}{L_0} = \sigma_E(1+\varepsilon_E) \tag{S5}$$

Assuming that the load F is divided into n incremental steps, and each incremental step results in the same increase δ_L, where δ_L is defined as:

$$\delta_L = \frac{L - L_0}{n} \tag{S6}$$

Thus, the total true strain is as follows:

$$\begin{aligned} \varepsilon_T &= \varepsilon_1 + \varepsilon_2 + \varepsilon_3 + \cdots + \varepsilon_n \\ &= \frac{\delta_L}{L_0 + \delta_L} + \frac{\delta_L}{L_0 + 2\delta_L} + \frac{\delta_L}{L_0 + 3\delta_L} + \cdots + \frac{\delta_L}{L_0 + n\delta_L} \\ &= [\frac{1}{L_0 + \frac{L - L_0}{n}\times 1} + \frac{1}{L_0 + \frac{L - L_0}{n}\times 2} + \frac{1}{L_0 + \frac{L - L_0}{n}\times 3} \\ &\quad + \cdots + \frac{1}{L_0 + \frac{L - L_0}{n}\times n}]\frac{L - L_0}{n} \end{aligned} \tag{S7}$$

Integral calculus yields the following:

$$\varepsilon_T = \int_{L_0}^{L} \frac{1}{x} dx = ln(L - L_0) = ln\left(\frac{L - L_0 + L_0}{L_0}\right) = ln(1+\varepsilon_E) \tag{S8}$$

Substituting Equation 8 into Equation 5 yields the transformation formula between true stress-strain and engineering stress-strain:

$$\sigma_T = \sigma_E(1+\varepsilon_E), \varepsilon_T = ln(1+\varepsilon_E) \tag{S9}$$